Mission rapport – Suriname – 28/11 to 20/12/2001

Ph. Marie, December 2001

A- Objectives of the mission

At the beginning of the program "Restructuring of the banana sector in Suriname" the objective was to evaluate the state of art concerning the banana production situation in SURLAND. The analysis of the different production factors could be made by comparison with the deep analysis survey made by CIRAD in 1995 during the "Consultancy to advice on improvement of productivity and quality of banana industry" (EU contract 1/95, DG8, 000212). At the end of this analysis, the technical elements of the operations of the work plan had to be defined.

B- Review of the situation of the different sectors

1- Program of the visits

30 November 2001:

- Visit of Jarikaba 2: Mr Cameron, product manager.
- Pests and diseases control: Mrs S. Nanhoe

01 December 2001:

- Drainage and irrigation management: Mr Paul Pierpont

03 December 2001:

- Visit of Jarikaba 4: Mr A. Amatroessijat, Farm manager
- Cable way: Mr H. Girdhari

04 December 2001:

- Visit of Jarikaba 3: Mr A. Wongsodimedjo (Farm Manager)
- Discussion with Mr. F. Pinas

05 December 2001:

- Discussion with M. Tjon Sieuw, Mr D. Jairam (Depute Manager of Nickerie), K. Nanda (Pests and diseases)
- Visit of Nicherie 1, Mr D. Datadien (Farm Manager)

06 December 2001:

- Visit of Nickerie 2: Mr Sieuwnarain (Farm Manager)
- Technical Services: Mr Kromontono

07 December 2001:

- Interviews of a few supervisors and foremen

08 December 2001:

- Synthesis with Mr. Tjon Sieuw

10 December 2001:

- Discussion with Mr. A. Li FO Sjoe

12 December 2001:

- Drainage situation profile. Jarikaba 1. Paul Pierpont

18 December 2001:

- Visit of Jarikaba 1: Mrs. M. Bissumbhar (Farm Manager)

2- Program of the meetings

29 November 2001:

- Reception and presentation of the SOFRECO Team
- Ministry of Planning and Development Co-operation (Plos): Mrs. Sasha Behari, economist.
- UE Office in Suriname: Mr. J. Roman, head of Office
- Presentation of the head office staff of Surland: Mr. J. Drielsma (Managing Director), Mr. Stanley Gulzar (Finance and administration Director), Mr. Tjon Sieuw (Production Manager of Nickerie), Mr. F. PINAS (Production Manager of Jarikaba), Mr. A. Li FO Sjoe (Director of agricultural Affairs), Mr. P. Pierpont (Irrigation/drainage).

11 December 2001:

- Visit of Mr. Power In Vitro Plants nursery

13 December 2001

- Synthesis of the situation. Presentation of the main conclusions to Surland staff.

13 to 19 December 2001

- Participation to the reports.

3- Agronomic situation of the sectors

The analysis of the situation of the different production sectors has been made through visits to the fields and packing stations, discussions with the production managers and by consulting the statistic data of Surland or analysis results of the pests and diseases services. For every sector a specific technical point has been pointed at with a greater attention.

3.1- General points concerning all the sectors

- The main point is the inadequacy and the inappropriateness of the inputs. This concerns both nutrients and pesticides (except for cercospora).
- The technical level concerning some important field practices is low: plantation techniques, pruning, density maintaining, effect of nutrients on the plant, long-term previsions of production, technical management and use of indicators...
- Some of the techniques used in the packing stations are efficient and correspond to a good quality standard but the waste level is high and many things could be improved. The work is slow.
- The managers are confronted to a lack of workers for field operations and to difficulties concerning the duration and the quality of the work.
- A technical plantation manual is available for the managers and technicians. It seems to be used permanently as a reference and is a good way for technical information.

3.1- Jarikaba 1

- Not visited

3.2- Sector: Jarikaba 2

3.2.1- General characteristics

- Total surface: 310 Ha
- Surface in production: 260 ha
- Young plantings: 5,8 ha
- Under water fallow: 22,8 Ha
- Abandoned surface: 23,5 Ha

- 4,784 t produced in 2000 i.e. about 18,4 t/ha
- 5,520 t expected for 2001 i.e. about 21,2 t/ha

3.2.2- Specificity

- Interesting capacity for the training of workers
- Technical choices are not always the good ones but the work is done
- Great attempt for innovation

3.2.3- Situation of the best parcels in production

- This concerns two-year-old parcels, planted after a 6-month fallow under water. In spite of a lack of fertilizers these parcels have an acceptable level of

productivity (estimed by the manager at about 25 t/ha but more probably close to 35 t/ha).

These plantations cannot assume their immobilization and their exportations with the little amount of N-P-K furnished by the classical fertilization plan. So the needs are furnished by the decreasing of the soil fertility, corresponding both in a decrease of the amount of cations maintained by the exchange capacity, and by the nutrients furnished by the organic matter degradation (only source of nitrogen). This explains that only for nutrition cause the relatively high level of production cannot be maintained for more than two or three years.

- The situation of those parcels seems to be normal during the first cycle of culture. But the pruning method used increases considerably the density of mother plants (nearly double). This situation produces an important rate of very small bunches and induces more work of in-efficiency inputs in the fields, and a waste of time for the transportation of relatively small bunches.
- The relatively good productivity is also due to the absence of telluric pathogens (nematodes and borer) due to the fallow effect. The dynamic of re-infestation is not controlled and no pesticide is applied when it occurs. This is another factor explaining the short duration of good productivity for those parcels.

Since an important re-infestation has not occurred, the productivity of those parcels can easily be augmented and partially stabilized in the time by the improvement of the pruning, the rationalization of the fertilizers and the control of the telluric parasitism.

3.2.4- 12 m beds trials

- Some hectares of 12-m-bed parcels have been installed as a trial consecutively to the recommendation of the 1995survey.
- The productivity obtained is low. It is evidence that those parcels suffer of heavy deficiencies in nutrients and of important populations of nematodes and borers. However the technique used cannot be considered as efficient.
- The surface morphology of the beds (absence of warping) does not permit the dripping of the exceeding water (rain or irrigation). On the contrary the water accumulates in the depression of the old intermediary drain between the two double lines of trees and stays for a long time: it has to be leached or drained in totality. In this situation the volume of water that has to be drained is superior (double in case of excess) compared to the situation of 6-m-beds. This, added to the fact that the drains are not deep enough (the advice was 1, 5 m) and, also to the excess of irrigation makes that the situation of those trials is (by theory) worth than in the current itinerary of drainage. For those trials the entire technique proposed has to be applied in the right way. If it is not, the effect on drainage (and may be consequently on productivity) is negative.

3.3- Sector Jarikaba 3

3.3.1- General characteristics

- ❖ Not reported

3.3.2- Specificity

- ❖ Good maintenance in field
- ❖ Correct maintenance of drainage even in the drains with irrigation system

3.3.3- Field techniques

- **Nutrition**

- ❖ During the last year there have been only 8 times 100 kg of urea per ha applications, and only one recent application of KCl.
- ❖ In the field a lot of deficiencies are visible: by order of importance potassium, nitrogen, calcium, zinc, manganese, sometimes sulfur. The deficiency of phosphorus is not visible in plantations but must also be very important.

  This can explain a great part of the low yields and of the quality problems in Surinam. A new program of fertilizers has to be done taking in account:
  - The cationic natural disequilibria of the soils : a great amount of magnesium respectively to calcium and potassium
  - The lack of phosphorus
  - The deficiency of nitrogen, potassium and calcium
  - The high anionic exchange capacity that don't allow the systematic use of KCl

- **Pests and diseases**

- ❖ It is clear that the most important parasitism problem of the plantation is borer. Even if the under water fallow can be very effective against borer there can be a rapid re-infestation from the planted parcels around. One of the possibilities for improvement would be to concentrate all the fallows in the same area to limit the problems of border infestation. For the moment the application of insecticide is necessary to control the current very bad situation.
- ❖ In some new parcels the control of the nematodes infestation of the planting material by hot water may not be effective and induces a limiting importance of the nematodes population even during the first cycles. Generally speaking the pressure is not high but in some parcels it can be a very important limiting factor and has to be systematically controlled by counting the different species present in the roots.
- ❖ Cercospora is correctly controlled in fields.

- **Density and pruning**

- ❖ While there are lots of limiting factors (lack of nutrients, soil parasitism, lack or excess of water) the only way to increase the yield is to increase the number of

bunches per hectare what is often done by keeping two succeeding suckers. This increases the cost per produced kg because of the great part of the manpower and inputs linked to the number of bunches (and not to their weight): gains, ropes, nutrient and pesticides (it should need one application per mother tree), pruning, fruit de-leaving...etc.

When those limiting factors are controlled it is much more interesting to reduce the quantity of bunches what improves their weight. It seems that even in the current conditions of the second cycle (when there is still no borer and nematodes) the maintenance of the initial density of 2,000 trees per hectare could be effective. This means that this technique should eventually be reserved to very old parcels before abandon.

3.4- Sector Jarikaba 4

3.4.1- General characteristics

- Total surface: 300 Ha
- Surface in production: 137.5 ha
- Young plantings: 9 (+8 planting now) ha
- Under-water fallow: 50 Ha
- Abandoned surface: 36.5 Ha

- 4,020 t produced in 2000 i.e. about 20,5 t/ha

3.4.2- Specificity

- Manager appointed only 4 month ago
- Bad field-maintenance and productivity
- Very few correct parcels
- 60 ha plot usable for new plantations

3.4.3- Management of the workers for the packing and fruit care

- 66 permanent workers
- 48 every day workers with a status of temporary workers
- 2 supervisors
- 1 former per bloc of 50 ha that makes the supervision of everything

- The first problem signaled is the absenteeism, especially on Monday (can reach more than 30%) and on Saturday (can reach 25%). Surland could not pay incentives for 3 month what de-motivated the workers.

This sector has to get workers from the others to be able to do the work.

- **Work in the packing station**

  - About 65 workers for 10h30 per day, packing between 2,500 to 3,000 boxes i.e. less than 700 to 840 kg per worker (non including controllers and management) what is a very correct ratio taking in account of the very bad coefficient of 0,4 to 0,5 box per bunch.
  - The work begins at 7h00 with 3 breaks (8h30 to 8h45; 12h00 to 12h30; 16h00 to 16h15). The breaks are organized not to stop the station 50% of the workers stay in the station and put back their break (new organization since 6 weeks).

- **Harvest**

  - 50 workers are affected to the harvest divided in 5 groups, everyone controlled by a foreman. In each group there are 5 carriers (who also put the cushions), 2 bunch cutters (1 make the choice of the bunch and cut the pseudostem to bend for putting the cushions and the other cuts the bunch and cleans the leaves), 1 checks, 2 hang on the trolley. (1 more workers have to be present at each circle switch to prevent the fall of bunches).

- **Work in the field**

The fruit care is organized on the same way in all the 50-ha blocs.

  - Monday: early bagging in the whole farm
  - Tuesday and Wednesday: bunch cleaning, counting, deflowering, and early bagging
  - Thursday and Friday: bunch cleaning, early bagging.

- **Short term prevision of work**

  - Every week (color) the number of flowers (of each parcel) is reported on a board. The number of bunches of the color harvested is reported for each week on the same board. So the number of bunches that stays in the field is known by difference. At the end of the harvest of the color the percentage of bunches harvested gives the percentage of: waste in field + count mistake.

3.5- Nickerie

3.5.1- General characteristics

Nickerie is divided in two sectors of 570 and 452 Ha. Both sectors are very similar. One commentary is done similar for the two.

3.5.2- Specificity

- Good maintenance of the drainage system
- Maintenance of the density in field

- ❖ Quality of the parcels superior to Jarikaba
- ❖ People have no problem with the quality of the soil
- ❖ Drainage water evacuated by gravity

3.5.3- Packing stations

- Ratio Kg packed / worker

  - ❖ Prevision of work for the day: 50 to 60 palettes for 123 persons (+ 3 foremen) what is a low ratio.

- Organization of the work

  - ❖ Over hanging: 6 persons
  - ❖ De-handing: 6
  - ❖ Rachis and take of labels: 3
  - ❖ Plastics, caliber, control of ripping: 6
  - ❖ Take off waste: 4

  - ❖ Selection: 3 (per line) x 6 lines : 18
  - ❖ Classification: 2 x 6: 12
  - ❖ Put label: 1 x 6 : 6
  - ❖ Weight: 1 x 6 : 6
  - ❖ Packers: 2 or 3 x 6 : 12 to 18
  - ❖ Spray: 1 x 6 : 6
  - ❖ Special line, put bags : 6
  - ❖ Return clusters in tank: 6

  - ❖ Mertec supply: 1
  - ❖ Cleaning station: 3
  - ❖ Sharp knifes: 1

  - ❖ Making boxes: 6
  - ❖ Give empty boxes: 2
  - ❖ Push full boxes: 2

  - ❖ Control boxes weight: 1
  - ❖ Control waste quality: 1
  - ❖ Counting boxes: 1

- ❖ Making palettes : 4
- ❖ Loading : 4

- ❖ Foreman for de-hanging to de-handing: 1
- ❖ Foreman for selection to sticker: 1
- ❖ Foreman for packing to loading: 1
- ❖ 3 supervisors during the harvest (field and station)

The low ratio of work can be explained by:

- ❖ Special works: the bagging of the clusters for special production
- ❖ Work that should not be done during the packing: cleaning (risk of increase of crown rot)
- ❖ Useless work: return of banana
- ❖ Problem of very small equipment: push of the full boxes
- ❖ Problem of equipment: spray, de-hanging
- ❖ Organization of work: elimination of wastes…

- **Problems of quality**

- ❖ De-hanging of the bunches
  - This operation submits the bunches to pressure, torsion and scares, a better technique has to be found

- ❖ De-handing
  - When de-handing, the hand goes down for a few centimeters and hurts the hand below. The plastic that protects the hand below is frequently removed when the upper hand is cut and can be an important reason of increase of damage.
  - The banacuts are all different, and the angle is not always correct and it can hurt. The movement made with the banacut is not the good one, so the crown is often too thin. When de-handing with a knife the workers have not the right position (not high enough) for the first and touches the bananas with the handle.
  - The hand is carried up to the tank by 2 or 3 bananas that can cause recent scarring between the fingers or neck injury.
  - The position of work is tiring and may give problems of regularity and precision at the end of the day. The hands frequently hurt the border of the tank, could hurt the rope in the tank...

    This operation could have a very important effect on the decrease of the quality in the station what could be controlled by the analysis of quality before and after de-handing.

- The plastics used to protect the hands during the cable-way transport could be a very important vector in case of crown rot presence.

❖ Selection

- The method of selection, finger per finger, is approximate what artificially increases the wastes.
- The selection criteria are very strict and do not integrate the normal percentage of acceptable defects. The instruction (not always respected) is to remove the both-side fingers of the hands what does not correspond to current international standards.
- The knives do not cut enough! The position of the knife in the hand is not always the good one; the movement of cutting is approximate.
- Most of the losses are very recent scarring (35% of recent scaring, 8% of scarring between the fingers, 3-4 % of neck injury) that cannot be found when analyzing the bunch quality before de-handing: this operation has to be precisely studied to be improved.

❖ Classification

- This operation seems to be correct. The doses of bacterol may not be sufficient.

❖ Fungicide spray

- The plastic used for protection touches the bananas and could be a source of crown rot infestation.
- The mixing of thiabendazole with alum sulfate is inefficient (no effect against crown rot - useless), only remains the effect of the fungaflor.
- The position of the worker makes nearly impossible the treatment of the cut pedicels. This manual system needs to be mechanized.

❖ Packing

- The position of the box is too high so the clusters can hurt the box when taken. The box is put on rollers and makes it very difficult to pack on a moving target. The packing seems to be correct.

❖ Palettes

- Palettization is perfect.

3.5.4- Long term prevision of harvest

- **Global estimation**

❖ A global estimation is made for the year for each of the 6 series this the next data:

- Average bunch-weight: average of the data observed during the preceding year

- Number of bunches/ha/year: function of the density (controlled by counting twice a year) and of the cycle (1.25/year for the old parcels and 1.5/year for the plantings)
- Global losses (estimated by the data of the past year)
- Average surfaces taking in account the program of plantings

- **Prevision per week**

❖ A prevision per week taking in account the dates of harvest is also done with the following data:
  - Number of hectares in production
  - Average number of flowers per ha (observed during the past years)
  - Estimation of the box/bunch ratio

❖ This technique could be more precise but it is the one adapted in case of contradiction with the preceding.

❖ However, these approaches are not sufficient to obtain a good estimation of the weekly production and will have to be improved.

3.5.5- The tasks

❖ The most important part of the work is organized and paid by task that corresponds to an agreement with the Trade Unions.

❖ 58 types of tasks have been defined, some taking in account the difficulty or the numeric importance of the work. In a first approach those tasks seem to correspond to normal quantities of work as in other countries.

3.5.6- Head management organization

Director --- Maintenance department (cable way, buses...) --- 3 supervisors & 3 foremen
|
Farm manager
--- Statistic coordinator
--- Quality supervisor (1 + 1 foreman)
--- Assistant manager pests and diseases (1 supervisor) technical link /Jarikaba
--- Assistent Farm Manager (1 Nickerie 1, 1 Nickerie 2)
|
Supervisors (1 for each serie)
|
Foremen (one for each bloc 40 to 50 ha, 2 for each packing station)

The information seems to circulate fluently in the organization, which can be considered as classical and effective.

4- Technical services

4.1- Drainage and irrigation service

4.1.1- Risk of salinity in Jarikaba

Jarikaba is supplied in water by a canal coming from the Saramacca River, i.e. with a very low content of sodium. But a study (1996?) has shown that traces of salinity from the sea could go up to less than 30 km from Jarikaba during the corresponding dry season.

Banana cultivation is known to be sensitive to salinity. So the question was asked of the sustainability of the production considering the risk of macroevolution of the climate or of exceptionally dry seasons.

- Banana has a certain resistance to salinity (in fact it is an average sensitivity respect to the other cultivated plants): toxicity in sodium is visible for more than 3,500 ppm of dry matter in the leaf 3 (optimum between 50 to 140 ppm, no toxicity in sodium was observed during the survey of 1995)
- Such climatic events would have to induce a go up of the salinity of twice the distance occurred during the 1996 dry season!
- The tolerable increase of sodium in soil is about 8% of the exchange capacity (4 times the current level, if other nutrients levels are normal). It could not cumulate because of the annual leaching during the wet season.
- The toxicity in chloride exists (even if banana is very resistant to chloride: toxicity limit up to 2, 5 % in leaf 3) and would induce a decrease of the effective leaf surface with limited effects on the yield during the dry season. This risk could occur in case of permanent use of KCl inducing accumulation of chloride (with more important risk in old parcels with poor organic matter level) and toxicity during the wet season.
- The risk of salinity cannot be considered as a limiting factor for the sustainability of Jarikaba plantations.

4.1.2- Drainage

The current system of drainage (beds of 6m with drains of 60 to 90 cm when maintained) is efficient to obtain a good leaching of water of about 25-30 to 40-50 cm. In these kinds of soil (with good chemical potential) this would very certainly be enough to obtain 7 or 8 hands bunches in industrial cultivation conditions i.e. to be competitive in the case of Suriname.

Nevertheless it is clear that when the problems of pruning, nutrition and parasitism will be reduced to normal levels, the drainage will become the first limiting factor if the drains are not perfectly maintained. Furthermore this dispositive induces important constraints in the organization of the plantation for:

- Difficult circulation when harvesting,
- Very difficult maintenance of the drains (and its bad effects on the soil)
- Problems for clearing to apply fertilizers and pesticides (problem of residues)
- Difficult irrigation maintenance...etc

The performance of this system is clearly lowered by the position (in the drains!) of the irrigation system in the case of Jarikaba.

The system of 12 m beds proposed in 1995 must improve the drainage! (And not only the organization of the plantation):

- As the beds are larger the drains must be deeper for the same efficiency
- The excess water must not penetrate in the soil and can be dripped (beds warped)
- The frequency of drains maintenance must be reduced (gentle slopes, maintaining of weeds or cover plant in the slopes, put of organic matter in surface when planting...)
- The water conductivity of the soil can be improved (work soil to mix the structural units and improvement of biological porosity that will have been partially destroyed by the soil work (disposition of residues or use of cover plants, use of good planting material...), improvement of stability (calcium, organic matter)...

4.1.3- Irrigation

The system installed in Jarikaba is not classical in banana plantations, and has two major constraints:

- it is not possible to do the drainage maintenance in normal conditions and this may highly increase the hydromorphy
- it cannot be removed easily for re-plantations or moved up on the beds. This system is not suitable for the Suriname conditions.

The procedure of choice of an irrigation system must take into account: the organization of the plantation (drains, passages...), soil surface permeability (mm per hour), dimension (climatic demand), cost, easy to mend, simple to install, easy to remove, spare parts supply, disease effects (cercospora), energy needed, quality of the distribution, risk of damage, sensitivity to wind, adaptation to the water quality ... If the system has not all the required qualities, solutions to every problem has to be found by the farm manager working with the irrigation specialist who proposes (and installs) the system.

The doses of irrigation per day have been initially fixed to the maximum climatic demand of the dry season (estimated 7mm/day for a normal parcel). This is far too much away from what is really necessary, considering the importance of vegetation in the old parcels and the fact that the excess of water is as detrimental as the lack. The best is to begin with average doses and to adapt it during the season in function of the soil and trees state.

In such a soil the hydric soil stock theory does not work well to adapt the every daily doses of irrigation. We can propose another irrigation management system based on the changes of soil volume.

4.2- Pests and diseases

4.2.1- Cercospora

The situation concerning cercospora is very good in the fields: the pressure is low and the number of leaves is not limited by cercospora (limited by deficiency in potassium). This situation is normal at the end of the dry season and will permit to pass the difficult transition

between the dry and the wet season in rather good conditions. So the improvement of this sector is not a priority.

The present number of 23 to 25 treatments per year with partial use of systemic products is a lot too much. This means that the cost of this sector and its impact on environment could be decreased. The use of bio-climatic forecasting, the improvement of the treatments quality and the implementation of a resistance control by monitoring can improve the strategies to alternating the products.

Both data of Stover and French system are taken in Nickerie as a comparison, so it will be possible to compare the two forecasting systems. This will help to considerably improve the disease control.

4.2.2- Borer

The borer has been identified during the survey as one of the first limiting factors in the plantations of Surland. But there is no regular procedure for its control in Jarikaba; a regular control is done in Nickerie every 6 month.

The current control procedure used consists in the counting of the number of adults found in half pseudo-stem traps (10 per ha, during the wet season, one observation after 2days). This method is efficient only when the borers are active. This means that if no borer is found in the traps it cannot be concluded that no treatment is needed. This technique, if it is used alone or punctually in the time, is inefficient as a systematic control system. The simplest technique would be to keep record of the percentage of plants with borers tunnels on 40 plants per parcel (plants from which the bunch has just been picked out). In the current situation there is an average of more than 2 adults per trap in about 80 % of the Nickerie parcels, the situation seems to be worst in Jarikaba! It is a disastrous situation.

4.2.3- Nematodes

The regular control of this important pathogen does not exist at the moment.

One application of nematicide has been done last year (Furadan). It has been shown during the survey of 1995 that the impact of nematodes on productivity in these particular conditions was far less important than the one of borers. May be, the use of an insecticide instead of nematicide would have been more operant in many parcels: the regular use of the control techniques should have been maintained in order to get able to make the right decisions.

In Nickerie, when there is no borer, the theoretical decision of treating is taken when more than 35 trees per ha are fallen, what could not be a bad technique if the absence of borer tunnels is controlled in the fallen trees bulbs.

5- Planting material

The technique of hot-water-clean-up of the planting material is very heavy, not always effective and gives very bad results at the beginning of the growth. It has to be abandoned and replaced by vitroplants.

The vitroplants currently used come from Mr. Power laboratory and have a lot of quality problems:

- Variety: the variety multiplied is poyo. The trials in Surland field and the international experience clearly show the production superiority of the Williams (even in current conditions of Suriname) and of the Grande Naine (in industrial conditions). As a first step the *William should be chosen*.

- Homogeneity: one mother plant is used to make every of 400 vitroplant clones. This gives much risk of genetic particularities. The performance of the origin mother material has not been checked. The only way to guaranty a perfect homogeneity is to *use only one perfectly checked mother plant*.

- Control of CMV (Cucumber Mosaic Virus): this virus is present in all the banana production areas of the world and can perfectly be multiplied through in-vitro culture. *There is no control procedure*.

- Control of BanMMV (Banana Mild Mosaic Virus): this virus is not well known but seems to be present in every production area (present in the West Indies where the bananas used in Surinam come from). This virus does not make symptoms but increases considerably the virulence and the capacity of dissemination of both BSV and CMV viruses. *There is no control procedure*.

- Control of BSV (Banana Streak Virus): according to the last data about the apparition of this disease, this virus must be present in Suriname and probably in Surland plantations (by proximity with ABB banana). Even if the risk of multiplication of infected plants is very low, it should be taken in account considering the efficiency of this way of dissemination and the effect it would have on the yield. *The banana varieties containing balbisiana genome should be urgently eliminated from the nurseries*.

- Control of BBTV and BBMV (Bonchy Top Virus and Banana Bract Mosaic Virus): those virus are not present in the region but should be controlled in case of multiplication of recently introduced varieties.

- Somaclonal variation: if the multiplication technique is respected for every meristem (and not in average of the production) the rate of somaclonal variation may be very low. The variants type chimera and mosaic-like (massada) are eliminated. Dwarf variants are not found and not eliminated (they exist and are eliminated everywhere else in the world). Green variants are eliminated frequently (to our knowledge this type of somaclonal variation is very rare and should not be taken in account in normal multiplication conditions).

- Vegetative quality: the techniques used in nursery are very heavy and rustic. The plants show various deficiencies in nutrients and poor vigor.

- Control of nematodes: a control of the nematodes content is made at the end of the 2nd phase of the nursery but nematodes where never found. Considering the use of natural soil of the plantation and the use of non filtered water it seems impossible not to have infestations by nematodes (high risk for species of meloidogynes, risk for helicotylenchus and may be Criconemella and Tylenchorhynchus which effects on banana plantations are not known, and may be low risk for Radopholus similis if there were no more banana left for a long time where the soil is taken and in place of the nursery). The sampling techniques, or may be the extraction techniques should probably be improved and in a first approach the use of systemic nematicide should be systematic.

This laboratory has not the technical capacity to solve these problems and no specialized laboratory will accept to transfer its technologies. The solution could be an association with a high technical level laboratory based on a separation of the work (last phase of growth in laboratory and nursery phases made in Suriname) completed with a technical assistance. A contact with Vitropic has been proposed. In these conditions it must be possible to rich prices inferior to 0.7 US$ per plant with the best level of quality.

C- Synthesis on the agronomic situation of the banana plantations

1- Climate and topographic situation

The climate is perfectly suitable with very rare wind damage which is a very important advantage compared with the West Indies or parts of Africa. The topography is perfectly flat which gives possibilities of mechanization (cable way installation is possible in the whole surface); water is directly available in quantity and quality. The practice of the under-water-fallow is easy what is a very important advantage of the situation: 3 to 6 months only are needed to obtain a perfect fallow. In the other situations of ACP countries 1 to 2 years are necessary with an important work of maintenance for worse results.

2- The soil

The soil is heavy clay (60%), with an average capacity of drainage of 2 to 3 m/day, with a good exchange capacity (25 %), excess of Magnesium in comparison with the other cations, and now deficient in Phosphorus, Calcium and Potassium for banana cultivation. Even if it is not comparable with the originate situation of presence of an organic layer, the level of organic matter is still high (>5%).

Compared to the other banana situations, the physical characteristics are medium (necessity of perfect drainage, not sensitive to compaction), and the chemical characteristics are good. The sensitivity to soil parasitism (nematodes and cylindrocladium) is low.

The theoretical drainage currently practiced is suitable for the banana but could be improved. It induces a lot of organization problems of the banana plantation (problems of erosion and maintenance, passages, repartition of residues...).

3- the quality of the planting material

The variety cultivated is natural Poyo. It is very rustic (can give an acceptable quality production even in very difficult agronomic conditions which is the actual situation) but the plant is high with a poor productivity. The tests done with vitroplants of Williams variety are effective. Grande Naine could be tested.

Most of the plantation has been planted with bulbs treated by hot water against soil parasitism. Even if the sanitary state is acceptable, this material is poorly vigorous and very heterogeneous and must by abandoned. The planting material must be stabilized to Vitroplants (perfect sanitary quality, perfectly homogeneous, vigorous with good genetic characteristics).

4- Situation of pests and diseases

The cercospora situation is good, but the techniques used induce too many treatments per year and are not suitable as a preparation in case of black cigatoka arrival.

The banana weevil borer is very important because of a lack of strict control for many years. It has an important effect on the yield decrease.

Nematodes have a lowest yield effect due to the soil quality and the exceptional performance of the fallow, but they must also be strictly controlled.

4- Technical itinerary in the field

The only fertilizers applied during the past years where Nitrogen, Potassium and Magnesium. The quantities were too low, and the quality was not adapted to the soil situation.

The control of the soil parasitism was poor: systematic (no control of the pest presence before decision of treatment), and not always done with the best products.

The maintenance of density permits to maintain a correct repartition of the plants on the surface for many years but often induces the conservation of two succeeding suckers per mother-tree that gives small bunches for the succeeding cycle.

The weed control is excessive. The maintenance of the sanitary situation by de-leaving is acceptable. The fruit care is just correct and can be improved.

An under-tree irrigation system only exists in Jarikaba and is not suitable in the conditions of Suriname: not removable, installed in the drains…

The results of all this is a poor productivity in the field: small bunches with an average number of hands not exceeding 5 after de-handing, short fingers... In these conditions the resistance to scaring and ripening should be correct except after the dry season.

The work is organized by 40-to-50-ha blocs under the responsibility of a foreman who organizes all the tasks. The remuneration of the work is mainly indexed to the quality of the task corresponding to an agreement with the labour unions.

5- The harvest

The long term and short term harvest previsions are approximate and don't take in account the situation per parcel and the changes of average daily temperatures during the year.

Like the work in the fields, the harvest is organized per blo,c which can be problematic for control and in the case of Jarikaba where a new system of fixed cable way has been installed. The bunches are cushioned before transport to save scarring.

6- The packing stations

The work in the packing stations is also organized per tasks. There is a great percentage of losses due to recent scaring that should be reduced but the outgoing quality level is high.

The new packing stations equipment corresponds to international standards but most of them are obsolete and should be renewed.

D- Justification of urgent needs of fertilizers and pesticides

An initial budget for the modification of the basic technical itinerary to a normal standard of industrialized banana production in Surland plantations must be obtained in emergency. This chapter presents elements of agronomic justifications:

The low yields obtained by Surland banana production cannot allow Suriname to be competitive in the EU market. Its financial situation is difficult and should be bailed out by increasing the banana production. To obtain rapid results in production the basic principle of the cultivation itinerary used in Suriname must be changed.

The local natural conditions offer important advantages in comparison with the other ACP production countries: non-existence of black sigatoka, water availability, and flat areas suitable for mechanization, high sun brightness, and low impact of nematodes... But there are also important constraints: soil physical properties, soil chemical characteristics, presence of high populations of banana weevil borer. Elaborated husbandry practices now permit to lower soil imperfections in order to obtain the best expression of the plant genetic potential respectively to the climatic conditions.

In the current situation most of the factors limiting the bunches' weight are due to limited agronomic intensification: lack of nutrients, soil parasitism, lack or excess of water... In this current situation the only way to increase the yield was to increase the number of bunches produced per hectare, which is often done by keeping two succeeding suckers per tree. This way increases the cost/kg produced because of the great part of the manpower and inputs linked to the number of bunches (and not to their weight): put of the gains and ropes, nutrient and pesticides (need of one application per mother tree), pruning, fruit de-leaving and deflowering...etc.

When those limiting factors are controlled it is much more interesting to get one succeeding sucker per initially planted tree and to obtain relatively fewer but heavier bunches.

To give this rapid potential to Surland, basic limiting factors must be controlled: mineral fertilization and soil parasitism that have been scientifically identified as the main limiting factors during a deep agronomic survey done in 1995.

The control of those main limiting factors will have a direct effect on the yield and will be essential to give a potential for the profitability of the investments (in place and future). The data available about the agronomic situation (characterization of the soils, pests and diseases control) permits to deduce the needs.

This means there will be need for an important budget increase devoted to fertilizers and pesticides, comparable to other banana industries but which has no precedent in the Surland history and which could not be supported by the actual financial situation.

The effect of this action on the yield increase can be estimated through the variability study in the plantations and calculation of the average yield of specific few constrained parcels (real data). The average estimated yield is up to 26 t/ha.

The analysis of the current cost price and the prevision of its changes after the modification of the basic technical itinerary show that the financial return will permit to maintain the normal level of inputs for the succeeding years.

These basic urgent modifications will be managed through the specific action plan of the first year including:

- Specific training to the applications quality
- Specific training for pruning
- Constitution of work teams specialized in pesticides techniques
- Organization of the tasks scheduling at the scale of the parcel
- Agronomic control procedures for the application of the techniques
- Biologic control of the efficiency

The effect of a good fertilization program and of adapted chemicals applications is not instantaneous but it is a preliminary action to the efficiency of the other improving actions and has to be done in emergency.

E- Elements of the action plan

1- Measures aimed at improving the varieties strategy and the cropping techniques

The new plantings will be the basis of the future Surland yield. A new strategy could be build taking in account all the constraints of the new technical expected itineraries: one of the difficulties will be to regroup the parcels: grouping of the fallows for a best efficiency, to facilitate the maintenance of the installations and drainage...

It is a long-term strategy including the harvest previsions and a several-year plan has to be done. All the techniques must be improved to permit the longest best productivity of these

new parcels: planting techniques, soil tillage, drainage, and fertilization. Vitroplants also give its better results with a very special technique of first cycle pruning that has to be introduced. The density maintenance techniques must also be the best for the succeeding cycles.

The best quality of vitroplants must also be chosen and terms and conditions of supply must be defined in order to prevent the introduction or the multiplication of new viruses (special guaranties) and to obtain the best quality for reasonable price in legal conditions.

With all those data the work of identification of the eventual suppliers and of evaluation of their capacity to produce the quality and needed quantities can be done.

2- Measures aimed at improving the watering cost-efficiency

2.1- Drainage

A deep study of the present situation will permit to know how to make a progressive improvement of the system. The possibilities of underground irrigation must be checked for, which soil mapping may be necessary. Procedures of conception and maintenance of the new drainage are also necessary.

2.2- Irrigation

The installation of automatic weather stations will permit to build a new strategy of irrigation management which could be first tested in experimental plots. The procedure of choice of the material can be improved. A system of control of the costs has to be built. The organization of the other field activities must be adapted to the irrigation situation.

3- Measures aimed at improving the banana growing management, soil maintenance and fertilization cost-efficiency

3.1- Nutrition

The nutrition quality should be controlled by yearly soil and plants analysis. This will permit to put in place a long-term strategy of improvement and maintenance of the soil chemical fertility. The possibility of use of complete or bulk forms of application can be studied taking in account the economic constraints.

3.2- Sigatoka

To improve the actual system and to be prepared to the eventual black sigatoka arrival, a bio-climatic forecasting system can be used. Periodic anti-resistance monitoring will give the state of the efficiency of the chemicals and permit to experiment new strategies. The quality of the spraying systems has the most importance to obtain a good efficiency and must be deeply assessed. The system must also be sustained by strict management procedures.

3.3- Weevil borer and nematodes

The treatment strategies must be based on the observation of the qualitative pest presence at the level of every the parcel. A general strategy can be built and managed integrating the record keeping of every chemical used action.

3.4- Post-harvest treatments

The current strategy of chemicals use may, for some part, be inefficient and has to be deeply reviewed.

3.5- Weed control

A complete review of the current luxuous system can be proposed and could induce changes of chemicals, frequencies and material.

3.6- Pests and diseases watch

A permanent watch must be maintained concerning the pests and diseases of less importance with strategies to prepare most of the eventualities. In particular the eventual arrival of black sigatoka should be identified as soon as possible.

4- Measures aimed at improving off shooting cares and fruit bunches haulage cost efficiency

The plastic bags used for the bunches protection in the field have not the required qualities and must be changed. A deep review of all the tasks has to be done to reduce the importance of the losses.

The production forecasting system is not enough precise and has to be reviewed taking in account the weather parameters and the relationship between the grade and the green life duration.

The choice of the ready-to-harvest bunches can be improved.

A complete review of the Jarikaba cable-way and the choice and installation of the Nickerie one are essential to prevent losses. During this work the systems of cushioning and of hanging / de-hanging bunch could also be improved.

A new harvest organization system at the plantation scale can be proposed.

5- Measures aimed at re-organizing packaging plan

The scarrings are the most important cause of losses and should be reduced by the identification of the most sensitive work posts and the selection improvement.

A deep assessment of all the packing station organization can be done in order to propose a new organization respecting the existing tasks, controlled by the use of ratios. The useless tasks have to be suppressed.

New system packing stations adapted to local conditions (cost of the work and high quality required) can be proposed. In Nickerie the use of potable water will have to be introduced and generalized.

6- Training plan of the labor

For all the field and packing-stations work a permanent training network has to be elaborated: the notion of « metier » has to be developed.

Concerning the head management one of the deepest training seances will permit the stabilization of all the forecasting systems needed: long and shor-term harvest prevision, forecasting of the pests and diseases and of the nutrition, use and interpretation of the ratios.

7- Measures aimed at improving the work efficiency in the field

In the current situation of relatively high labor-cost, studies have to be done about the financial interest of weed control mechanization of the big drains and about the possibilities of use of the irrigation system for the application of fertilizers. The use of small material in the field or in the packing-station could also improve the quality and efficiency of the work.

A system of work control by the use of ratios must be systematized with a special attention to the frequency of the recurrent tasks. This could be a basis to generate a competitive emulation between the different farms.

8- Measures aimed at cost-cutting inputs procurement

The introduction of all products and material must correspond to a strict definition of terms and conditions. The conditions of storage are to be reviewed to maintain the initial product qualities.

In the domains of fertilization and chemicals the possibilities of use of multiple suppliers can be improved for example by the ratification of several efficient chemicals for the same use.

8- Measures aimed at improving the innovation capacity

A research and development team could be constituted in order to manage the future developments of Surland plantations concerning the most important subjects that are – the introduction of good agricultural practices and environmental norms, - the strategies of introduction of new varieties of banana, - the diversification.

A demonstrative plot using all the best agronomic management techniques of banana cultivation could be set up.

Number of trials should be done to permanently improve the technical itineraries concerning for example: Theresa system of irrigation management, the fertilization quality, the adaptation of the green life duration to the minimum needed, the use of pheromone traps against weevil borer, soil tillage and use of organic matter.

9- List of the proposed actions

9.1- Measures aimed at improving the varieties strategy and the cropping techniques

- Definition of the quality standards and control methods for the vitroplants
- Identification of a local supplier
- If there is no suitable local supplier elaboration of a strategy to put in place a nursery (installations, suppliers, training of workers…)
- Re-organization of the soil preparation (drainage and irrigation before planting, weed and pests control…)
- Training on the plantation techniques
- Training on specific first cycle pruning
- Training on pruning for next cycles

9.2- Measures aimed at improving the watering cost-efficiency

- Modification of the procedures for material choice
- Adaptation of the work organization taking in account the irrigation
- Change and adaptation of the doses in function of the climatic data and the soil characteristics
- Improvement of the control system

9.3- Measures aimed at improving the banana growing management, soil maintenance and fertilization cost-efficiency

- Design and implement an agronomic productivity control per parcel
- Design and implement a long-term strategy for re-planting
- Design and implement a system of annual control of the nutrition (soil and plant analysis)
- Review the strategy of drainage maintenance
- Design and implement a long-term strategy of soil chemical improvement
- Analyze the possibility of use of complete or bulk fertilizers

9.4- Measures aimed at improving the chemical cost-efficiency

- Expand the range of chemicals taking in account EC, Fyffes and Suriname standards
- Review the storage quality
- Design and implement biological control system for the weevil borer
- Design and implement counting control for nematodes
- Design and implement bio-climatic control of sigatoka
- Review the whole aerial spray system against Sigatoka
- Review the procedures of manual spray against Sigatoka
- Design and implement agronomic control of other pests and diseases
- Change the policy of use of the post-harvest treatments

- Change the strategy of weed control to reduce the frequency

9.5- Measures aimed at improving off shooting and fruit bunches haulage cost-efficiency

- Modify the quality of the Gaines
- Improve the fruit care quality
- Improve the quality of de-leaving
- Design and implement a control system of the green life duration
- Calculate average ideal date of harvest per week
- Design and implement a system of short-term prevision for harvests taking in account temperatures

9.6- Measures aimed at improving the harvest

- Training for the bunches choice
- Detailed review of the Jarikaba cable-way system
- Choice and installation of Nickerie cable-way
- Modification of the cushioning system
- Modification of the hanging/de-hanging system
- Change of the harvest organization

9.7- Measures aimed at improving in the packing stations

- Introduction of small material
- Training for the selection
- Identification improvement of the sensitive posts for scarring and modification of the techniques
- Choice of a packing station system adapted to local conditions
- Building of new packing stations in Nickerie
- Use of potable water in Nickerie
- Elimination of useless tasks

9.8- Measures aimed at improving the work efficiency in the field

- Study of the interest of mechanization for the current manual weed control of the drains
- Make study concerning the possibility of fertigation (N, K)
- Introduce small material to improve the efficiency of pesticide applications (induce re-agreement of the tasks)
- Fix the frequency of the tasks, when possible, to increase the control performance

- Design and implement an agronomic general production control based on the use of simple ratios
- Design and implement a competitive comparison system of the work efficiency between Jarikaba and Nickerie

9.9- Measures aimed at improving the innovation capacity

- Create R&D team
- Design and implement a 50-to-100-ha plot with 12m-beds and underground drainage (if possible), wind-brakes, Grande Naine, cover plants....
- Make trials to adapt a new system for irrigation control (Theresa system)
- Make trials in prevision of new fertilizing programs
- Make study to strictly adapt the harvest date to the need of green life duration
- Make trials on the efficiency of new control systems of borers
- Make trials on the use of biological products
- Make trials on decision of production of fruit not post-harvest treated
- Make trials on soil work
- Make trials on the efficiency of organic matter inputs
- Build a strategy for new banana varieties
- Study the possibilities of diversification
- Prepare access to good agricultural practices norms

F- Proposal of terms and conditions for the importation of in-vitro cultured plants in Suriname. Conditions for good ready-to-plant in-vitro cultured plants quality

1- Sanitary problems

The most important is not to introduce in Suriname banana plantations new pests or diseases or new types (more virulent or that could be combined with present types) of existing diseases and not to multiply existing types of diseases by in-vitro techniques.

1.1- Measures for origin plant material

1.1.1- The tissue cultured plants must be imported in-vitro (aseptic conditions) otherwise no credible guaranty could be obtained (nearly all the existing pests and diseases could accidentally be introduced by this way).

1.1.2- CMV (Cucumber Mosaic Virus) guaranty: Each sucker initially introduced in vitro must have been indexed by a DAS-ELISA test (sample = part of the basal pseudo-stem, both positives and false positives samples have to be eliminated).

1.1.3- BSV (Banana Streak Viruses) guaranty: All the mother plants of the parcel origin of the suckers must have been indexed for BSV by the most recent techniques of the molecular biology. The origin parcel must only contain AA or AAA banana plants and be far from all other types of banana (in particular plantains and Hybrids containing Balbisiana genome) and far from all sugar cane fields. The country of the origin parcel must be declared free from episomal BSV form even if spots of single plants may have been mentioned and destroyed during the past.

1.1.4- BBMV (Banana Mild Mosaic Virus) guaranty: This guaranty is also very important because of the capacity of this virus to highly improve the virulence of both CMV and BSV. But a serious guaranty is difficult to obtain because only two laboratories have the necessary techniques (USA and France) and the tests are still not commercialized. To limit the risks, the mother plants of the origin parcel should have been indexed by microscopic observation techniques. And recurrent control procedures should be put in place. In this case it would be better to introduce only polyclonal varieties (great number of different mother plants).

1.1.5- BMV and BBTV (Bract Mosaic Virus and Bounchy Top Virus). The parcels origin of the suckers must be situated in countries where those viruses still not have been identified. The origin mother plants must have been indexed for these two viruses.

1.1.6- Other filamentous viruses. Microscopic observation techniques should have been used during the indexation of the origin mother plants.

1.1.7- Moko disease. The parcels origin of the suckers must be situated in countries where this disease is not present.

1.1.8- A special attention must be given to the situation and the maintenance of the origin mother plants and to the specific adaptation of the procedures of permanent control.

1.2- In-vitro measures

1.2.1- For other bacteria types a recurrent general check-up of the bacteria present in-vitro should be done. A special attention must be given to the absence of erwinia types.

1.2.2- The procedure of amplification must permit a perfect tracability of all the plants produced up to the mother origin plant.

1.3- Nurseries measures

1.3.1- CMV secondary infestations. Specific measures must be taken to prevent CMV secondary infestations by the strict control of potentially infected weeds or cultivated plants and a strict control of the potential vectors (permanent close of the installations to prevent the plants attractiveness, preventive aphicides (specific research would be necessary to demonstrate the feasibility of a technical itinerary without insecticide treatments)...). In the best case a DAS-ELISA systematic control of an aliquot of the ready-to-plant material could be done. A permanent visual control and a perfect knowledge of the CMV symptoms are necessary.

1.3.2- BSV secondary infestations. Potentially infecting plants must not be present inside or around the nurseries in particular sugar cane, plantains, hybrids and more generally all banana containing Balbisiana genome.

1.3.3- Radopholus similis prevention: No trace of the presence of Radopholus similis should be tolerable. Specific internal systematic control procedures should be implemented with specific sampling and analyzing system.

1.3.4- Other nematodes. No presence of living other types of nematodes should be allowed. Specific preventive measures have to be progressively implemented: use of guarantied substrates, filtration of the irrigation water, control procedures ...

1.3.5- Other parasitism. Specific measures of normal control of all banana other pests and diseases should be implemented.

2- Genetic quality

2.1- Genetic characteristics of the origin material.

The agronomic performance of the vitroplants will be linked to the choice of the origin planting material that can be polyclonal (several genetically different mother plant) or monoclonal (one only origin mother plant for all the production), in this last case the best very strict sanitary procedures for the prevention of viruses must have been taken.

2.1.1- Polyclonal origin material. To prevent problems of lack of homogeneity in the field the mother plants must have been chosen close to the ideal type wanted. A secondary

phase of homogenization must have been implemented respecting a strict procedure based on the observation of agronomic parameters and on a statistic system of control in special trials or in the origin parcel of the suckers.

2.1.2- Monoclonal origin material. If the origin material does not correspond to a standard plant from an official collection (case of clonal selections) its characteristics, compared to the standards, must be indicated especially concerning the productivity and the sensitivity to pests and diseases.

2.2- Somaclonal variations

2.2.1- Measures in laboratories: The interaction between the genetic potential and the techniques used in the laboratories can induce various percentages and qualities of somaclonal variations. The characteristics of each lot of vitroplants must be relatively stable, minimum and clearly characterized for each selection at the end of the laboratory phases.

2.2.2- Measures in nurseries: An efficient system of elimination of the off-types must be implemented including a systematic statistic control procedure based on the total and relative percentages expected for all off-types. A maximum percentage of off-types must be guarantied at the end of the nursery operations.

3- Vegetative quality

3.1- Size of the plants

The size of the plants must be homogeneous: not more than two leaves between the smallest and the biggest plants, last leave at the stage of 30 to 40 cm. The general aspect and stature of the plants must be stable. This means that there must be a clear accordance between the calendars of production and of plantation.

3.2- General appearance

When planting, the vitroplants must be in a normal growing phase and must not show abnormal symptoms of deficiency or a too high sensitiveness to sun burn. The vigor of the root system must permit the coercion of the substrate when the can is removed at the moment of planting.

SOFRECO

Project: *Restructuring of the banana sector in SURINAME*

Minimum estimation of the financial return

		Quantities		Costs			
Additional cost of the modification of the technical itinerary		Quantities	Units	Costs/unit	Units	Cost/ha (US $)	Total Costs
Nematicide	Rugby	40	Kg/ha	3.7	US $/Kg	149	
	Application	4	Day/Ha	10	US $/Day	40	
Insecticide	Confidor	2,5	L/Ha	93.2	US $/Kg	233	
	Application	4	Day/Ha	10	US $/Day	40	
Fertilisers	CaCO3	1300	Kg/ha	169	US $/T	220	
	Phosphate (DAP + Tr. Phos.)	100 + 700	Kg/ha	373 + 178	US $/T	163	
	Uree	800	Kg/ha	271	US $/T	217	
	KCl + KSO4	800 + 600	Kg/ha	271 + 339	US $/T	421	
	Application	7	Day/Ha	10	US $/Day	70	
Modification of pruning technique	No additional cost						1553 US $ /ha
Increase of the production	Harvets labour Packing labour Material	350	Boxes	1.74	US $/Box	609 US $	2162 US $ / Ha

Financial return of the increase of the yield	Quantities /ha		price / unit		Price / ha	Difference
Direct increase of productivity revenue (first year)	350	Boxes	7.5	US $/Box	2597 US $	435 $ / Ha

Estimation of the increase of yield with existing data

Actions	Fertilisation (N, P, K, Ca) Borer and nematodes control	Pruning, eliminate small bunches (< 5 hands)	Decrease of waste buches Fruit care, parasitism
Effect on the yield	Increase number of fingers Increase length and density	Increase number of fingers	Increase number of bunches Harvested
Origin of the data	Survey 95, descriptive statistics on 111 parcels	Analyse of the populations of bunches on 2200 units	Normal minimum average in industrial banana plantations
Effect on the yield (cumulative)	3.1 t / Ha	5.5 t / Ha	13.7 t / Ha
Effects after :	9 month	Precedent + 3 month	Progressive on 2 years

* separated for calculation but the effects of actions takes place at the same time